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A-frame and Training in the Metaverse to Develop New Professional Profiles in Communication

A-frame y la formación en metaverso para el desarrollo de nuevos perfiles profesionales en comunicación

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KEYWORDS

Immersive technologies
Virtual reality
A-Frame
Metaverse
New professionals profiles
Educational background
Educational intervention

ABSTRACT

The development of the metaverse and immersive technologies requires the training of new professional profiles with specific competences to design and manage interactive virtual environments. These also need to be aligned with specific frameworks such as the Digital Competences Framework for Citizenship (DigComp) and standards such as the European Skills, Competences, Qualifications and Occupations (ESCO) in order to harmonise training at European level and promote it in a growing market where advanced skills in digital content creation are in demand. Starting from a constructivist and experiential learning approach, this study will design, implement and evaluate training workshops based on project-based learning, using A-Frame as a tool for the development of immersive environments. The study, conducted with university students (n=51), follows a pretest and posttest design to analyse the perception of usefulness, satisfaction and acquisition of digital skills. Participants recognise the potential of A-Frame to integrate it into their future professional practise. The conclusion is that the training of future professionals must include multidisciplinary strategies that combine advanced digital skills and active methods. This is essential to meet the demands of an evolving labour market and to take advantage of the opportunities offered by the metaverse in the field of communication.

PALABRAS CLAVE

Tecnologías inmersivas
Realidad virtual
A-Frame
Metaverso
Nuevos perfiles profesionales
Formación educativa
Intervención educativa

RESUMEN

El desarrollo del metaverso y las tecnologías inmersivas requiere la formación de nuevos perfiles profesionales que dispongan de competencias específicas para diseñar y gestionar entornos virtuales interactivos. Estas deben, además, estar alineadas con marcos específicos como el Marco de Competencias Digitales para la Ciudadanía (DigComp) y estándares como el European Skills, Competences, Qualifications and Occupations (ESCO) para armonizar la formación en el ámbito europeo, e impulsarla en un mercado creciente en el que se demandan habilidades avanzadas en creación de contenido digital. Desde un enfoque constructivista y de aprendizaje experiencial, esta investigación diseña, implementa y evalúa talleres formativos basados en Aprendizaje Basado en Proyectos, utilizando A-Frame como herramienta para el desarrollo de entornos inmersivos. El estudio, realizado con estudiantes universitarios (n=51), sigue un diseño pretest y postest para analizar la percepción de utilidad, satisfacción y adquisición de competencias digitales. Los participantes reconocen el potencial de A-Frame para integrarlo en sus futuras prácticas profesionales. Se concluye que la formación de los futuros profesionales debe integrar estrategias multidisciplinares que combinen competencias digitales avanzadas y metodologías activas. Esto es fundamental para responder a las demandas de un mercado laboral en evolución y aprovechar las oportunidades que ofrece el metaverso en el campo comunicativo.

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1. Introduction

1.1. The role of the metaverse in the professional field and new professional profiles

The concept of the metaverse, rooted in science fiction (Stephenson, 1992), has evolved from its original meaning as a persistent virtual world allowing real-time interaction into a transformative digital element.

The successive technological advances, which Ioannidis and Kontis (2023) classify into four major stages, have integrated virtual reality, augmented reality, blockchain and artificial intelligence, expanding its possibilities (Mystakidis, 2022; Hwang and Chien, 2022). Against this backdrop, Meta's proposal, led by Mark Zuckerberg, presents the metaverse as a safe space for communication where these technologies converge (Jeon, 2021).

Beyond its etymological meaning, which considers it a universe beyond the known (Laurens-Arredondo, 2024), there are numerous definitions that describe it. Heath (2022) states that it is a computer-generated virtual space that users can access to interact with others in real time. And López-Belmonte et al. (2023) define it as a space where the barriers of time and distance break down.

The terms metaverse and immersive technologies are not synonymous, although they are closely related. In fact, the metaverse is built upon the technologies that comprise it, including virtual reality and artificial intelligence (Crespo-Pereira et al., 2023). To fully harness the potential of these tools, it is essential to understand the true role of the metaverse within the spectrum of immersive technologies, as well as its theoretical framework (Chen, 2023). For numerous authors, immersive technologies are a combination of physical and virtual elements that create immersive experiences (Elbert et al., 2023), including: 360-degree formats, augmented reality, and virtual reality (Suh and Prophet, 2018; Frechette et al., 2023), as well as emerging immersive technologies like volumetric video (Benitez-Aranda et al., 2025).

This set of virtual tools supports the development of what is known as Industry 4.0 or the Fourth Industrial Revolution (Rozo-García, 2020), characterised by digitalisation, technological automation, and the convergence between the real and virtual worlds (Rodríguez-Correa et al., 2023).

Included within this are the so-called convergent technologies, such as virtual and augmented reality (Mamani and Sucari, 2022; Villalobos López, 2024), which aim to achieve a significant impact on the market (Ocampo-Eyzaguirre et al., 2024). However, the technological development of these tools, further driven by artificial intelligence, points towards a new Industry 5.0, characterised by human-machine collaboration (Carro Suárez and Sarmiento Paredes, 2022). In it, the metaverse will play a key role in promoting sustainability and creating collaborative workspaces among companies, workers and consumers (Piccarozzi et al., 2024).

In this context, virtual and immersive technologies, which are effective for creating virtual environments, become essential elements for achieving the implementation of Industry 5.0 (Pérez-Domínguez, 2024). Thanks to their heterogeneous nature, they are all applicable across various fields of knowledge involving companies, universities and governments (Rodríguez-Correa et al., 2023).

This entire socio-technological and economic context highlights the urgent need to promote digital education from the earliest levels of schooling (Solórzano, 2020; Barberá-Gregori and Suárez-Guerrero, 2021) to ensure that at the university level, new professional profiles with digital skills can be trained who are capable of working with convergent technologies to create virtual spaces (Baca and Acosta, 2021).

Similarly, the acquisition of these skills should also be encouraged by governments and businesses themselves by designing specific techniques that contribute to continuous learning in digital transformation (Morales, 2020). These strategies must prioritise the user by applying principles of clear communication to facilitate digital and business transformation applied to new digital channels and devices (Prodigioso Volcán, n.d.).

In addition, to ensure both training and standardised recognition in these topics, capacity-building processes in the use of these technologies must be aligned with and adapted to international frameworks and standards.

On the one hand, this includes the European framework Digital Competence Framework for Citizens (DigComp), which outlines the essential skills European citizens should acquire to be competent in digital environments, and also identifies augmented and virtual reality as emerging aspects that must be taken into account within the digital ecosystem.

Moreover, it includes the European classification of skills/competences, qualifications and occupations (ESCO), which covers the skills and qualifications required for these new professional profiles. Aligning with this framework will help drive a constantly growing market where there is an increasing demand for advanced skills in digital content creation.

1.2. Metaverses vs. VR spaces. A-Frame as an introductory tool

Training in the use and functionalities of each convergent technology is essential for its proper application in communication projects. Depending on each project's requirements, the most suitable technology should be selected and its level of impact and effectiveness assessed (Monroy Andrade, 2024).

In terms of metaverse design, platforms such as Frame VR, Roblox and Spatial.io offer the possibility to shape spaces where users can share ideas and even work together virtually.

In the business world, having a metaverse provides a new digital space to strengthen brand value and position it strategically in the market of the digital age (Domínguez Pérez, 2023). In fact, an increasing number of companies are seeking to create their own metaverse where their employees can access a hub and a three-dimensional workspace (Villarreal Satama, 2022; Lévy and Zapata Ros, 2023).

However, when considering the purpose of developing a metaverse, various functional aspects must be taken into account. The metaverse is a meeting space for exchange, connection and interaction between users in a virtual environment through the use of avatars (Cheong, 2022; Kim et al., 2023).

In contrast, a virtual reality experience is not necessarily a metaverse in itself (Sanchez-Acedo et al., 2023). It is important to understand the difference between a basic virtual reality experience—where there are no avatars or interaction between users—and a metaverse, which does offer a space for virtual interaction.

Therefore, in the field of education, appropriate measures must be taken to train new professional profiles that are able to distinguish and accurately understand the functionalities of each technology for application in communication projects.

The gradual implementation of immersive technologies, along with the various products and solutions they enable, has positioned them in recent decades as advanced technological tools in the technical processes of various professional fields (Vasarainen et al., 2021).

In this regard, virtual reality environments have been applied across numerous professional sectors, such as the entertainment and video game industries, medicine and healthcare, art and exhibitions, educational didactics, journalism and communication, among others (Baía Reis and Coelho, 2018;

Zaman et al., 2024). The emergence of this technology in the professional world has driven the development of tools capable of creating immersive environments. As a result, solutions such as Unity have emerged—a tool that is widely used to develop virtual reality scenes (Jerald, 2014).

However, all these tools for creating 3D simulation environments come with a steep learning curve (Sánchez et al., 2024), which limits their use in certain production settings. To lower this barrier, more accessible options are available, such as the open-source software solution A-Frame (Santos and Cardoso, 2019).

This tool is an HTML framework developed by Mozilla in 2015 to build virtual environments (Korečko et al., 2021). A-Frame enables the creation of 3D, augmented reality and virtual reality experiences in the browser using HTML tags and A-Frame-specific entities (Moreno-Lumbreras et al., 2023). By using these tags, developers can add elements to the scene and modify them according to their own design and composition criteria (Gill, 2017).

This tool has been used by media outlets such as The New York Times to develop immersive products, including a virtual immersive tour through the streets of New York City. In it, users can explore various parts of the city firsthand by entering a WebXR environment (Martí-Testón et al., 2023).

Regarding education, this cluster of new realities provides a technological option that is available for teaching and is already being applied across multiple educational levels (Jiawei and Mokmin, 2023; Pandit et al., 2023). Technologies along the virtuality continuum, such as 360-degree video, augmented reality, and virtual reality, have also been employed to drive innovation in the development of educational resources (Mendoza et al., 2023; Rivas, Gertrudix and Gertrudix-Barrio, 2021).

In this sector, teaching experiences have also been conducted within the metaverse independently of the set of extended realities (Inceoglu and Ciloglugil, 2022). From a technological standpoint, Unity is the predominant tool in art and design school curricula (Hutson and Olsen, 2022; Yang, 2021; Zhang, 2021). In 3D development master's programmes, both Unity and the Unreal Engine are used (Lightbox, 2025; Trazos, 2025; U-Tad, 2020).

A-Frame, for its part, is being applied in educational settings in areas such as mathematics and industrial automation, as well as in use cases for interactive learning (Takac, 2020; Matahari, 2022). To support this, there are educational resources including several online courses, such as the one proposed by Delgado Horna (2018) and the one used in this study, available on Zenodo (see Section 7. Supplementary Material). Both include all the necessary documentation to start working with A-Frame on their websites.

To integrate these tools into the field of communication and information, journalists and professionals need quick and easy-to-use tools to design immersive journalistic content. In this regard, A-Frame is a viable option due to its ease of use when building virtual spaces, as it has a more gradual learning curve compared to other 3D development tools (Macario, 2024).

The inclusion of A-Frame in projects carried out by students with journalism and communication profiles requires the implementation of university training courses that incorporate active methodologies to enhance student learning and that promote the use of such tools within educational systems through Project-Based Learning or gamification.

Similarly, it is advisable to engage in new research that highlights the value of training initiatives on new virtual reality tools for application in educational and professional contexts alike.

1.3. Objectives

This study presents the design, implementation and evaluation processes of an educational intervention aimed at assessing the level of competence acquired by university students in the use of A-Frame as a tool for creating immersive environments.

The workshop covers key theoretical and practical concepts related to extended reality applied to the construction of simple virtual scenes.

The main objective of the study is to analyse university students' perceived usefulness, level of satisfaction, and degree of acquisition of digital skills in using A-Frame as a tool for developing immersive environments.

To achieve this, the following specific objectives are established:

- Objective 1: Design a course for creating immersive environments using A-frame.
- Objective 2: Based on the course developed, deliver a theoretical and practical in-person workshop for university students aimed at developing virtual scenes.
- Objective 3: Assess expectations on the use and usefulness, as well as the importance of the technology and the motivation to learn about immersive technologies.

The following research questions are established:

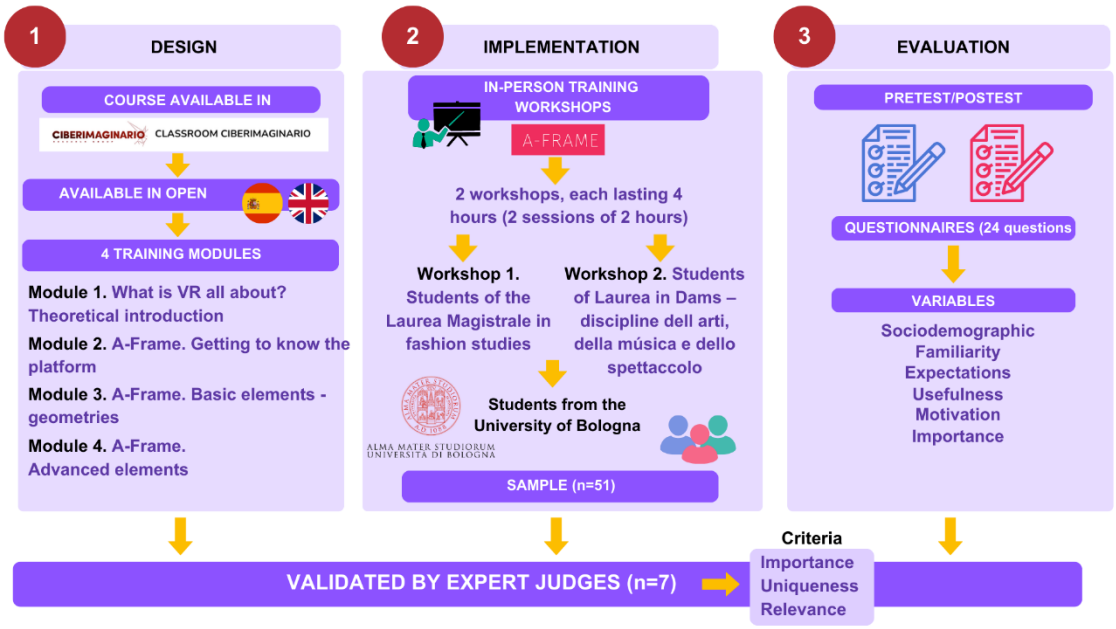
- R.Q.1. Is A-frame a simple and accessible tool for creating virtual scenes?
- R.Q.2. Is A-frame an appropriate tool for undergraduate students and communication professionals to develop immersive projects?
- R.Q.3. How do the expectations of the use and perceived utility of A-frame influence students' motivation to learn immersive technologies?

2. Design and Method

The methodological design of the study proposes an exploratory investigation that, by applying the active methodology Project-Based Learning (PBL) and a constructivist and experiential learning approach, involves the design and delivery of a training workshop aimed at university students, enabling them to create virtual environments using the A-Frame tool.

Figure 1 shows the methodological process carried out in the research.

Figure 1.
Methodological process.



Source: compiled by authors.

In the design phase, the content is organised into four training modules and hosted as an online course on the open-access platform Classroom Ciberimaginario. The course is available in both Spanish and English, and the materials used are accessible on the Zenodo repository (see Section 7. Supplementary Material).

In the implementation phase, the training is delivered through face-to-face workshops divided into two sessions of two hours each. Two workshops were conducted in two different undergraduate degree programmes.

In the first session, students are introduced to the theoretical concepts of extended reality and immersive technologies, and their usefulness for project development. This first session also introduces the concept of A-Frame, followed by a guided, hands-on activity in which students begin creating a basic virtual reality scene using HTML tags.

The second session is entirely practical and consists of guided exercises focused on integrating geometries, images, videos, audio, and 3D object animation into the scene. During this session, students create their own scenes, which they view at the end of the session using Oculus Quest 3 virtual reality headsets.

In the evaluation phase, a quasi-experimental pretest-posttest design is used to measure variables such as sociodemographic characteristics, familiarity, importance, motivation, usefulness, and students' expectations in the workshops conducted with A-Frame (Carbonell-Alcocer & Gertrudix, 2019).

To this end, a structured questionnaire with Likert-scale items was developed, based on the models proposed by Rinaudo, Chiecher and Danilo (2003) and Murillo (2006). The list of pretest and posttest questions by analysed variable is available in the Zenodo repository (see Section 7. Supplementary Material).

To ensure the rigour and quality of both the intervention and the instrument, as well as the design and implementation of the validation process, expert judgement validation was carried out following criteria of importance, univocity and relevance (Sánchez & Revuelta, 2005). The profiles

of these expert judges, as well as the anonymised results of the validation process, are available in the Zenodo repository (see Section 7. Supplementary Material).

3. Field work and data analysis

Once the model was designed and validated, the workshop was conducted with 51 university students from the University of Bologna (Italy) (n=51), enrolled in the Bachelor's degree in Disciplines of Arts, Music, and Performing Arts (Laurea in Dams – discipline dell'arte, della musica e dello spettacolo) in the course Computer Science for the Arts (Informatica per le arti), and in the Master's degree in Fashion Studies (Laurea Magistrale in Fashion Studies) in the course Data Science and Immersive Technologies for Fashion E-commerce.

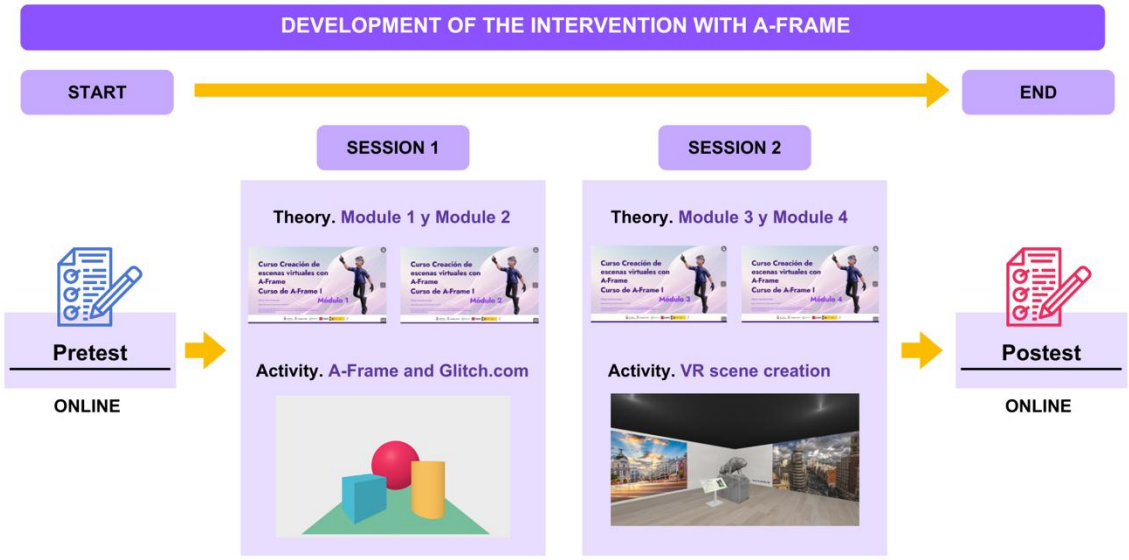
For the experiment, each participant was given an information sheet along with an informed consent form. It detailed the study procedure, as well as the guidelines and instructions. In addition, the participants were informed of their data protection rights, specifying that their data would be anonymised.

The data were collected during the second semester of the 2023–2024 academic year, coinciding with the teaching of the university workshops.

Pretest data were gathered at the start of the workshops, and posttest data were collected upon their completion. These data measure the educational intervention and the students' work in their training with one of the technologies that make up the metaverse, namely, virtual reality. A-Frame was chosen for its simplicity in creating virtual scenes.

Finally, a descriptive analysis was conducted using measures of central tendency (frequencies and percentages) focused on the variables of familiarity, expectations, usefulness, motivation, and importance. Figure 2 shows the intervention protocol of the training workshops.

Figure 2.
Intervention protocol



Source: compiled by authors.

4. Results

4.1. Characterisation of the course

The course content is divided into four training modules that guide students from the very beginning on how to work with the A-Frame tool.

The first module introduces, theoretically, the concepts of virtual reality and immersive technologies, as well as their classification within the virtuality continuum. It also covers the possible applications of virtual reality across various professional fields.

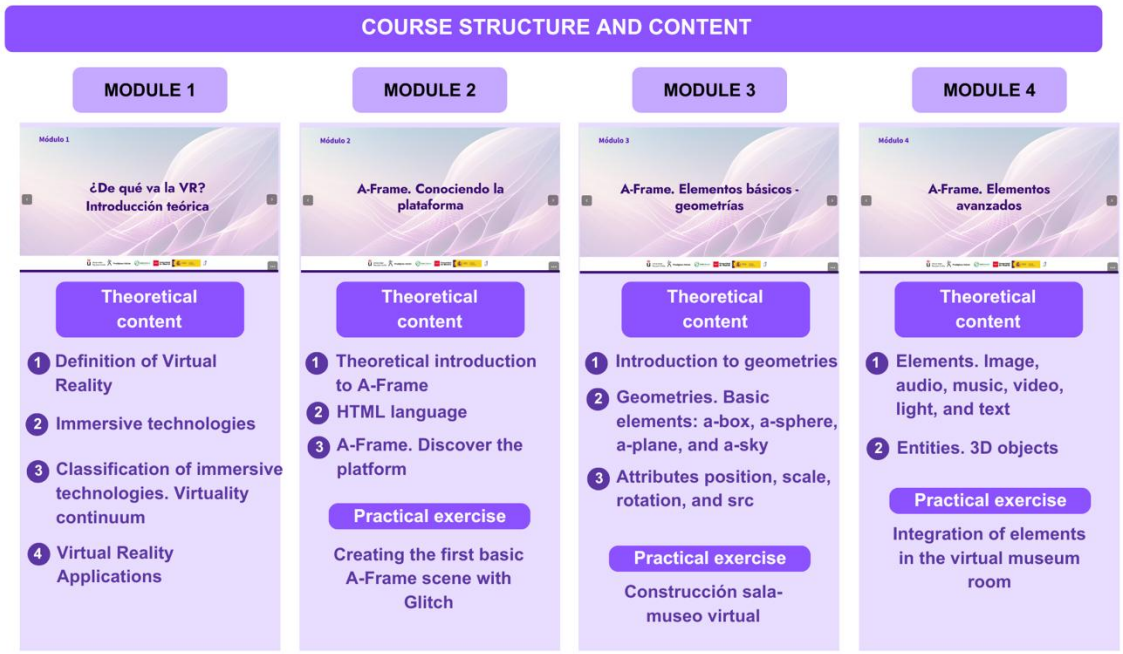
The second module presents the A-Frame platform and introduces the concept of HTML tagging, explaining the different parts of tags: attributes and values. This module includes a practical exercise using the Glitch.com platform, where students can work on their projects by integrating and editing HTML tags to build their virtual project.

The third module provides a theoretical and practical introduction to A-Frame's geometries: boxes (a-box), spheres (a-sphere), planes (a-plane), and backgrounds (a-sky). It explains how to integrate these elements into the scene, and practices with the specific attributes of each geometry. Additionally, the module describes the attributes common to all A-Frame entities: position, scale, rotation, and resources (src). The practical exercise for this module involves creating a virtual room using the basic box geometries.

Finally, the fourth module focuses on integrating advanced elements such as images, audio, videos, lights, text and animated 3D objects into the virtual scene. The practical exercise for this module is dedicated to completing the virtual room, where students can incorporate all the elements covered in this module to design their virtual reality scene.

Figure 3 shows the course structure divided by modules, detailing all the theoretical content and practical exercises developed in each one.

Figure 3.
Training structure and content of the A-Frame course.



Source: compiled by authors.

All the materials that make up the course were created using the Genially platform, which was used to design interactive presentations for each module.

4.2. Analysis of results and pretest-posttest comparison

This section presents the detailed results of the data analysis from the pretest and posttest questionnaires as percentages, focusing on expectations, importance, motivation, and usefulness. The anonymised results of both questionnaires are available in the Zenodo repository (see Section 7. Supplementary Material).

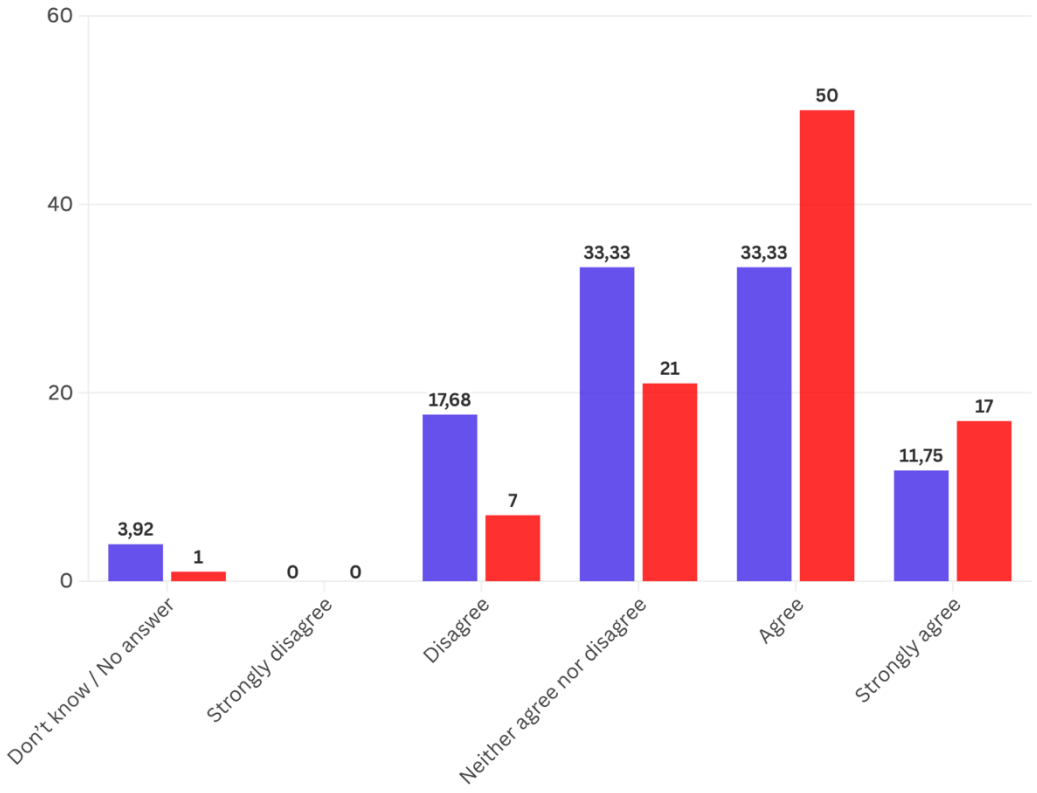
Regarding the sociodemographic variables characterising the sample, 78.43% of participants identified as female and 19.61% as male. In terms of nationality, 73% of the students were Italian, while the remaining 27% came from other countries.

64.71% of the students were not engaged in any other professional activity, with their main focus being their studies. Within this group, 54.9% specialised in Disciplines of Arts, Music and Performing Arts, followed by 29.4% studying in the field of fashion. The remainder were distributed among other specialities such as Italian language, design, and humanities.

Regarding the variables analysed, a comparative analysis was conducted of the pretest results (represented by the blue bar) and the posttest results (represented by the red bar).

Firstly, Figure 4 shows and compares the students' level of knowledge of the concept of 'immersive technologies' before and after attending the workshop.

Figure 4.
Pretest-posttest comparison of students' understanding of what immersive technologies are.



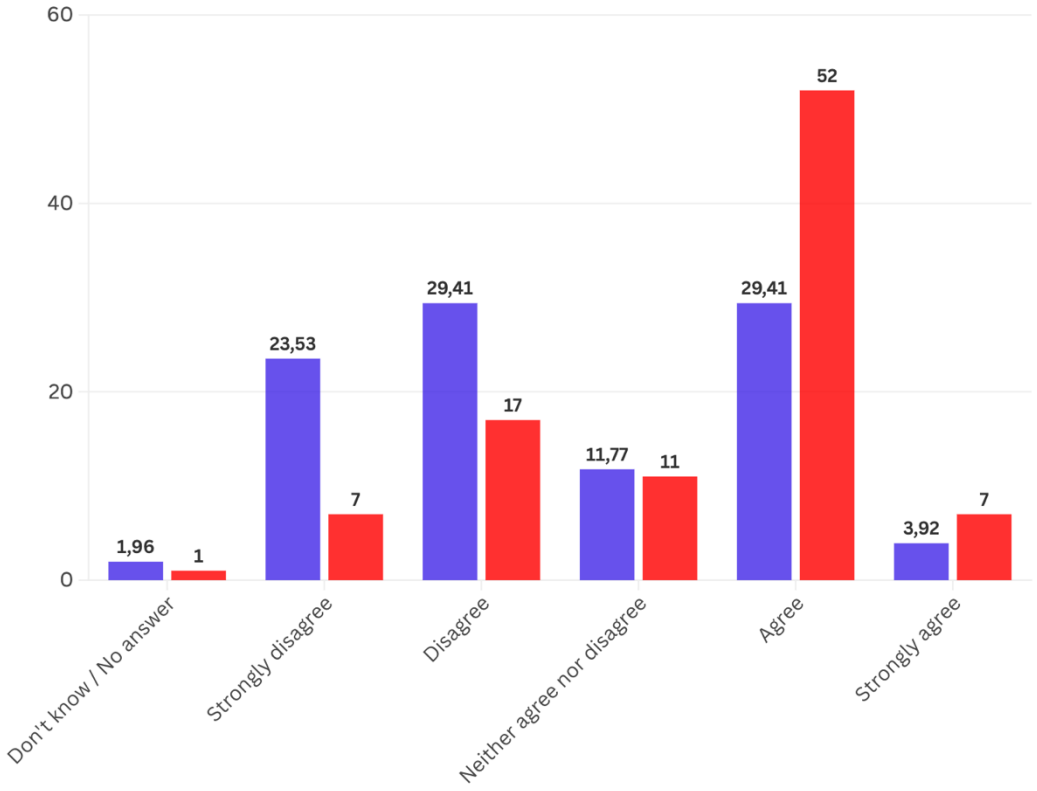
Source: compiled by authors.

The students reported that, prior to attending the workshop, most were not familiar with the concept of immersive technologies. Likewise, they were asked to name any tools they knew related to this

field. Among the responses, 9.8% stated they were familiar with augmented reality, and 37.25% with virtual reality, specifically mentioning headsets such as the Meta Quest 3.

In this regard, Figure 5 compares the results of the students' use of immersive technologies.

Figure 5.
Pretest-posttest comparison of the use of extended reality technologies.



Source: compiled by authors.

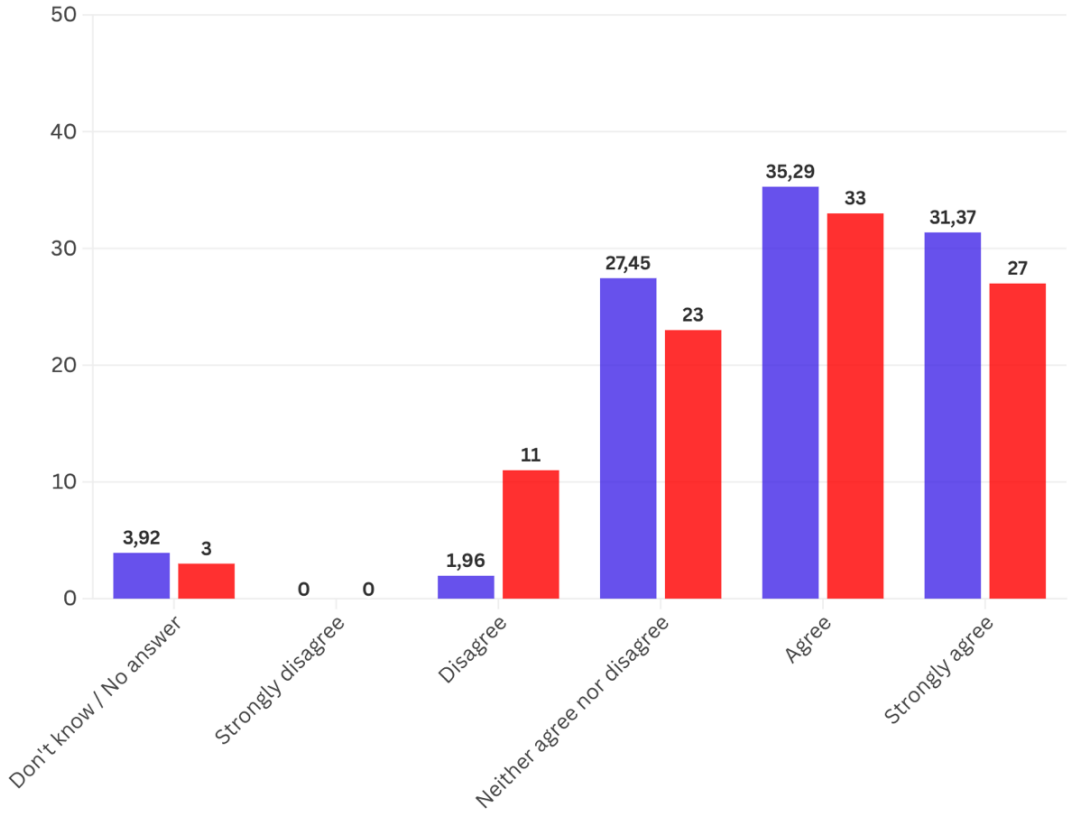
The workshop enabled most students to use immersive technologies—such as virtual reality headsets—for the first time.

Among the tools participants had used prior to the workshop, virtual reality was the only one of note, having been tried by 27.45% of respondents.

Regarding the potential application of this type of technology in their future careers or academic projects, prior to the workshop, 37.25% of participants strongly disagreed with its relevance. Another 31.37% disagreed, while 19.61% agreed and only 1.96% strongly agreed. After the workshop, the posttest results show that 13.72% of students strongly disagreed, 25.49% disagreed, 43.14% agreed, and 3.92% strongly agreed. Participants identified 360° video (19.61%) and virtual reality (31.37%) as the immersive technologies they are most likely to apply in future academic or professional contexts.

Similarly, Figure 6 illustrates whether students believe these topics are relevant to their future careers.

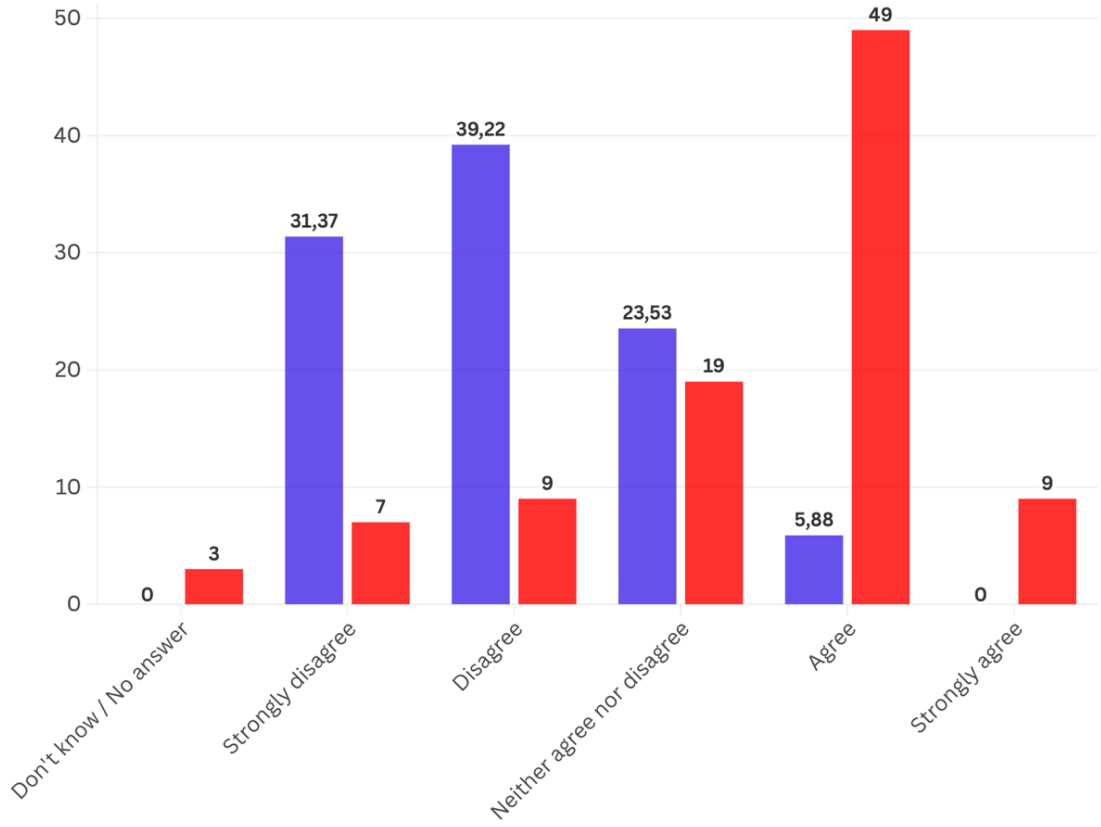
Figure 6.
Pretest–posttest comparison of whether students think the content is related to their future careers.



Source: compiled by authors.

As for the familiarity variable, Figure 7 shows the students' degree of familiarity with using the A-frame tool to develop immersive environments.

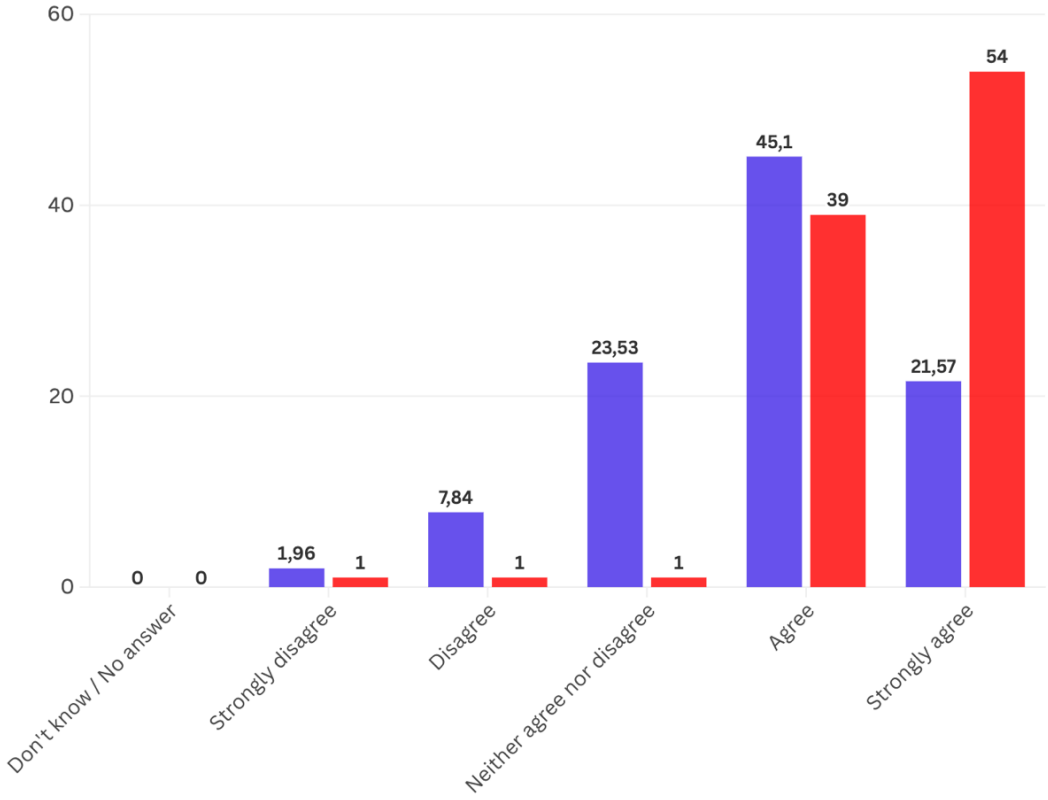
Figure 7.
Pretest-posttest comparison of students' degree of familiarity with A-frame.



Source: compiled by authors.

Regarding the expectations variable, Figure 8 compares the results on students' expectations at the start of the workshop and their perception of its usefulness once completed. After the training sessions, students regarded the workshop as useful.

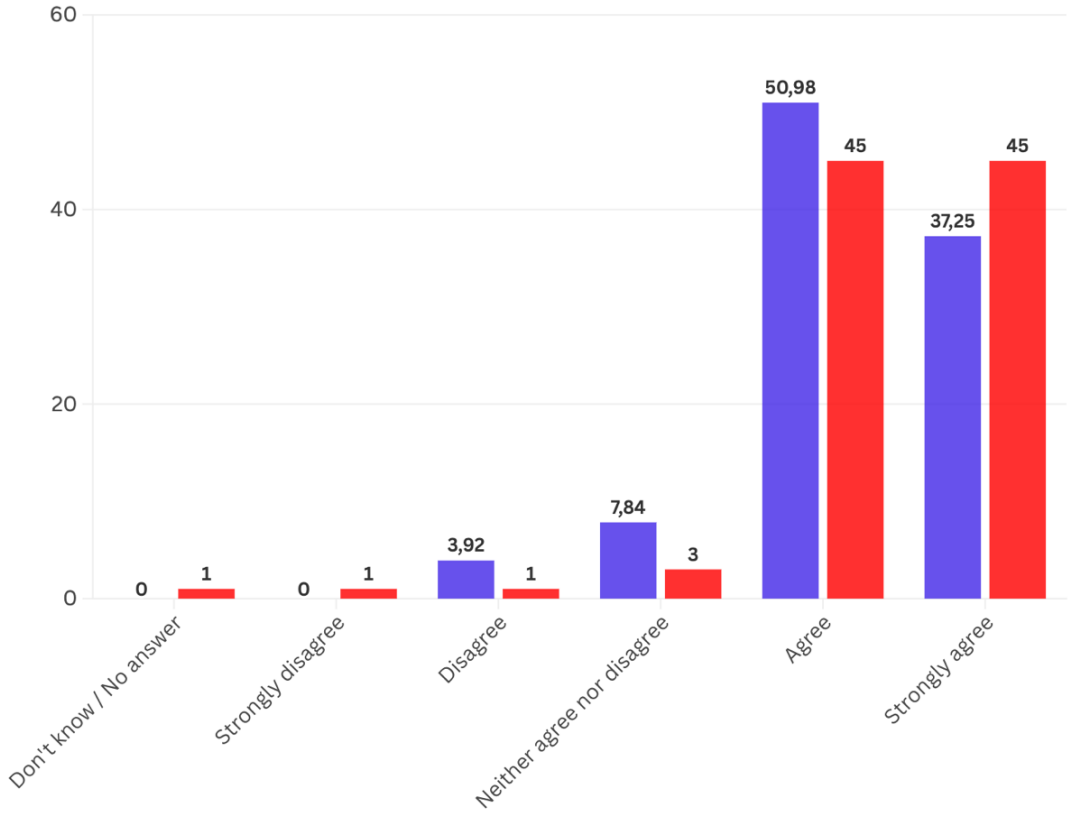
Figure 8.
Pretest-posttest comparison of expectations for the workshop.



Source: compiled by authors.

Similarly, Figure 9 presents a comparison between students' expectations regarding whether they would acquire new knowledge about extended reality after completing the workshop.

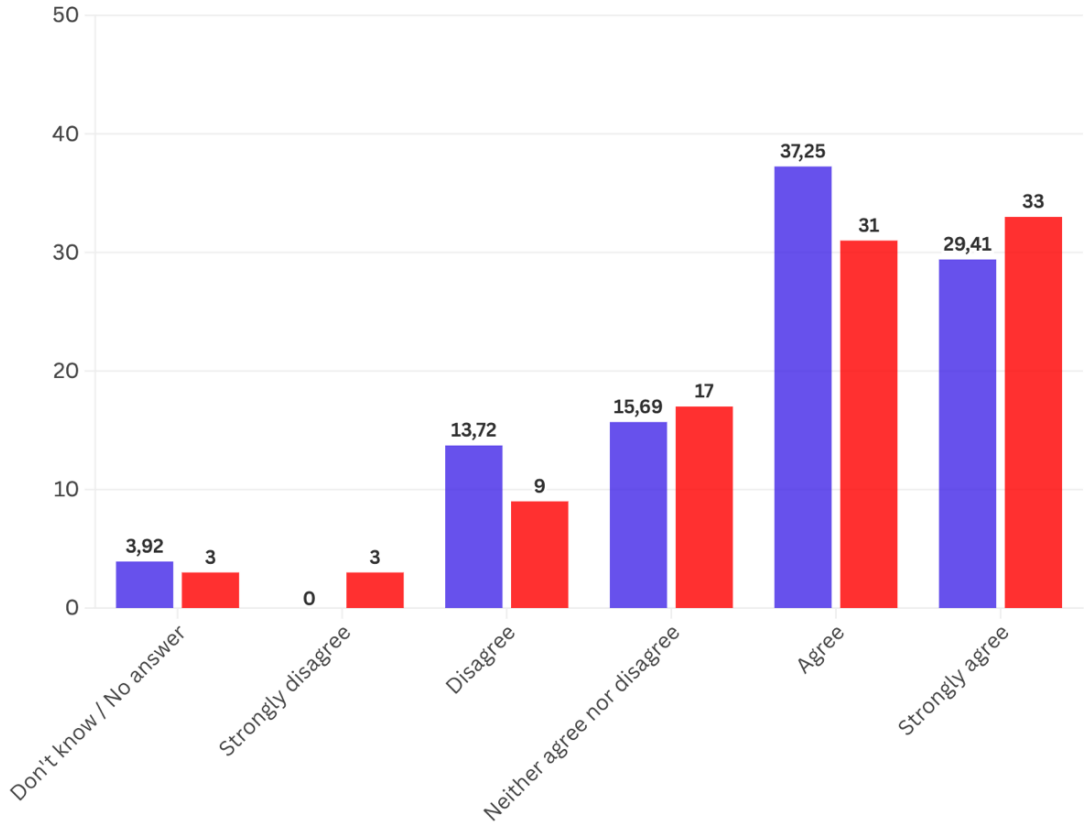
Figure 9.
Pretest-posttest comparison of the knowledge acquired in the workshop.



Source: compiled by authors.

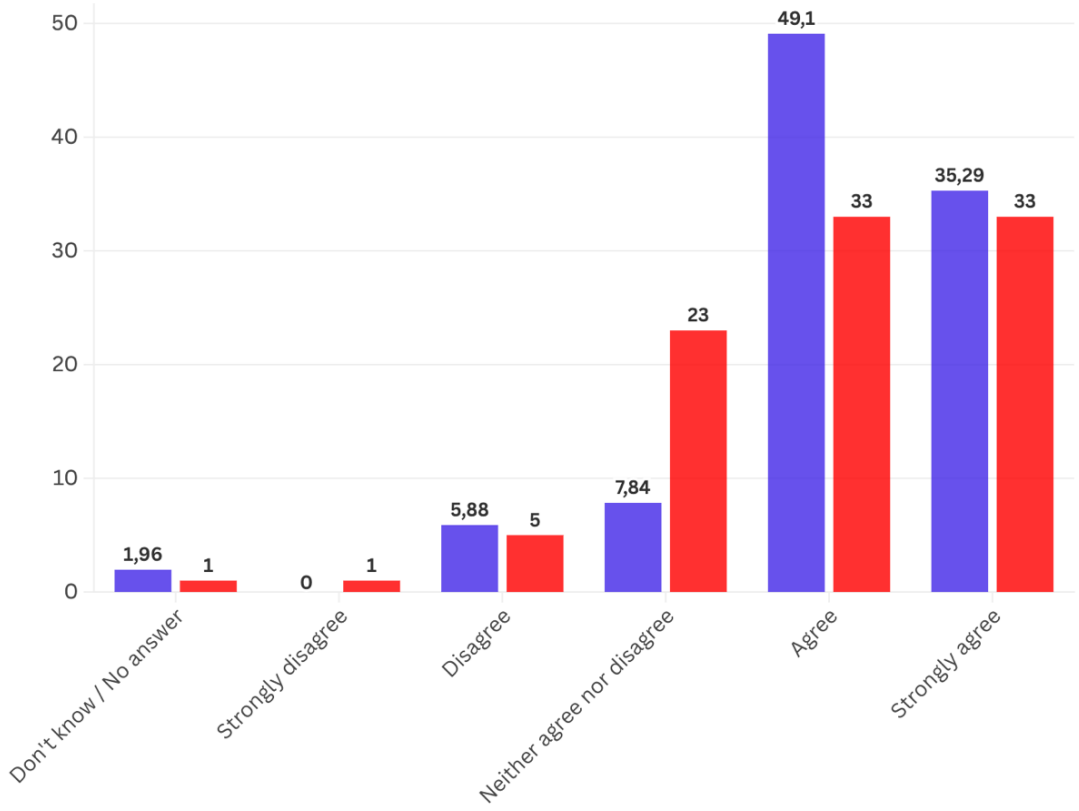
For the motivation variable, Figure 10 shows the pretest-posttest comparison of students' motivation to continue learning in areas related to extended reality, while Figure 11 shows students' interest in the subject of extended reality.

Figure 10.
Pretest-posttest comparison of motivation to continue learning about these topics.



Source: compiled by authors.

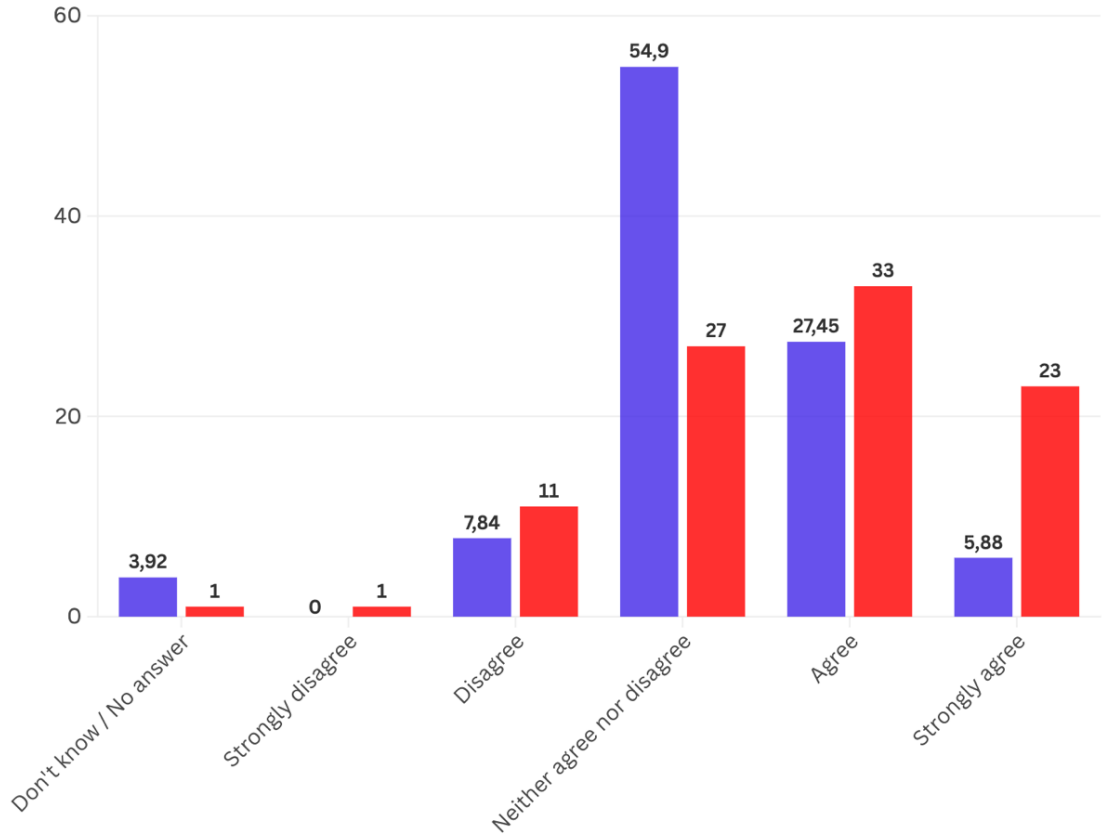
Figure 11.
Pretest-posttest comparison of interest in the subject of extended reality.



Source: compiled by authors.

To analyse the students' interest in the use of immersive tools in their future, Figure 12 shows the pretest-posttest comparison in this regard.

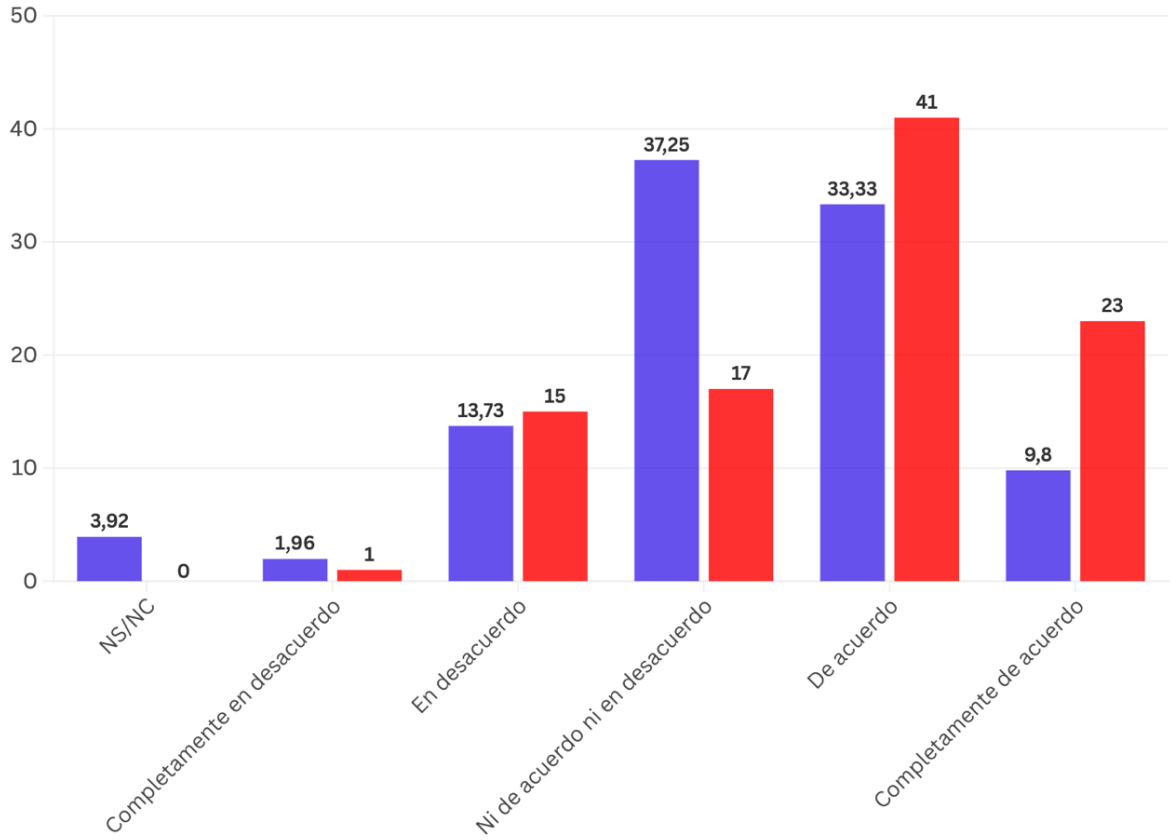
Figure 12.
Pretest-posttest comparison of interest in continuing to work with immersive tools.



Source: compiled by authors.

Specifically, Figure 13 shows the students' interest in continuing to use A-frame after the course is over.

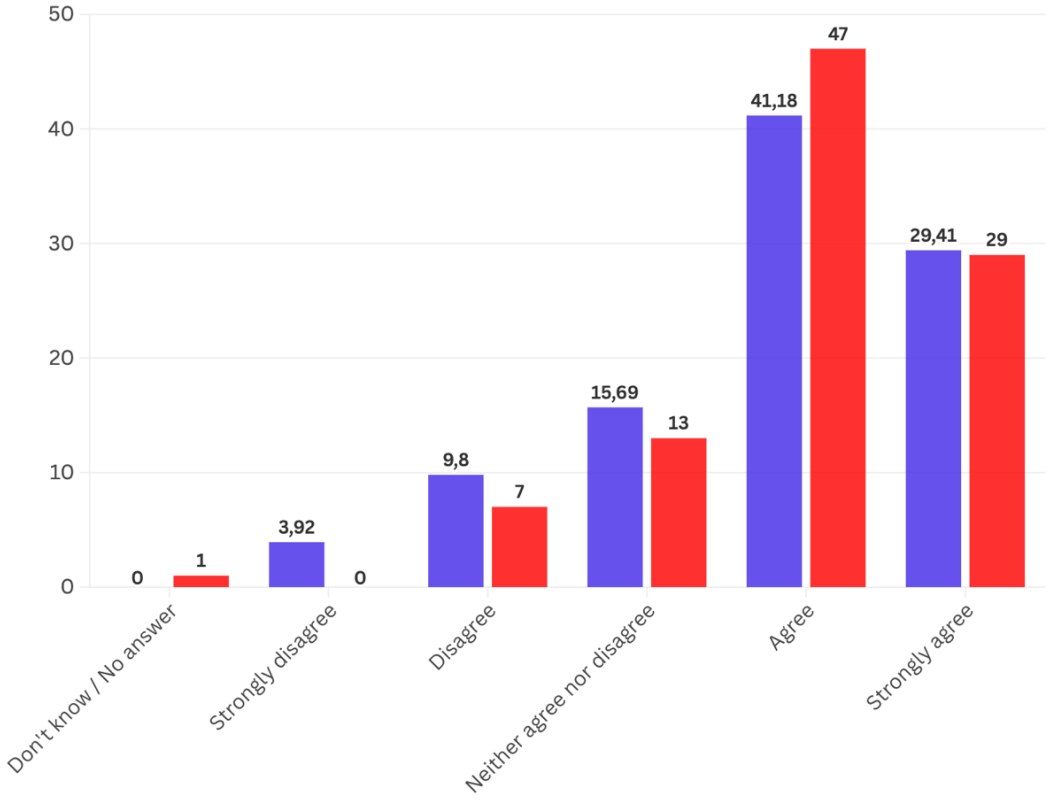
Figure 13.
Pretest-posttest comparison of the interest in continuing to work with A-frame.



Source: compiled by authors.

To analyse the ease of use of the A-Frame tool, Figure 14 shows how students rated this item at the beginning and at the end of the course.

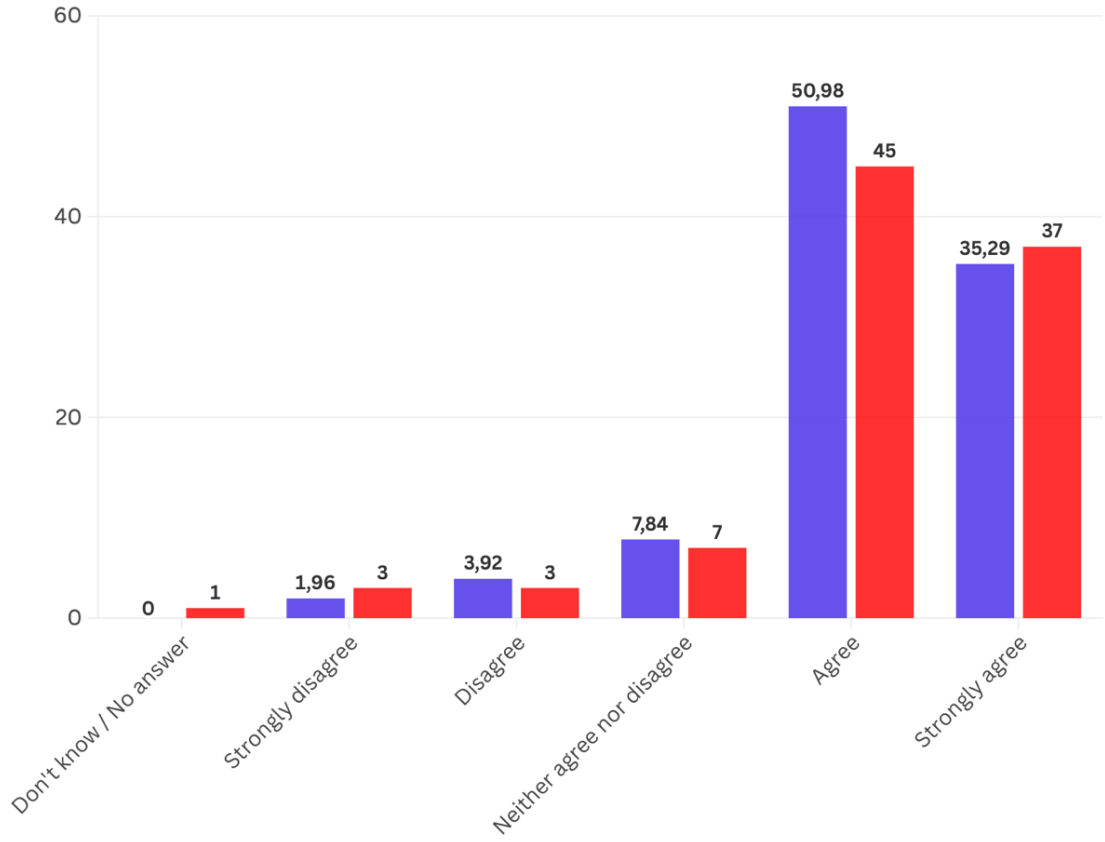
Figure 14.
Pretest-posttest comparison on the ease of use of A-frame.



Source: compiled by authors.

To measure the degree of usefulness of A-frame in building virtual scenes, Figure 15 shows the results.

Figure 15.
Pretest-posttest comparison of A-frame's usefulness in building virtual reality scenes.



Source: compiled by authors.

As regards the importance of A-frame as a tool for creating audiovisual content, in the pretest, 35.29% of respondents strongly agree with this. 50.98% agree, 3.92% disagree and 1.96% strongly disagree. At the end of the workshop, 37.25% strongly agreed on the importance of this tool as an audiovisual format, 45.1% agreed, 3.92% disagreed, and 3.92% strongly disagreed.

Finally, after completing the training workshops, most students considered prior training necessary to work with this tool. A total of 37.25% strongly agreed on the need for prior training, 41.18% agreed, 5.88% disagreed, and 3.92% strongly disagreed.

4.3. Virtual scenes made with A-Frame by the students

After the workshop, the students were able to create their complete virtual scenes using A-Frame. The virtual experiences they designed were authorised for publication in the Projects section on the XR COM LAB website of the Ciberimaginario research group (Ciberimaginario, n.d.).

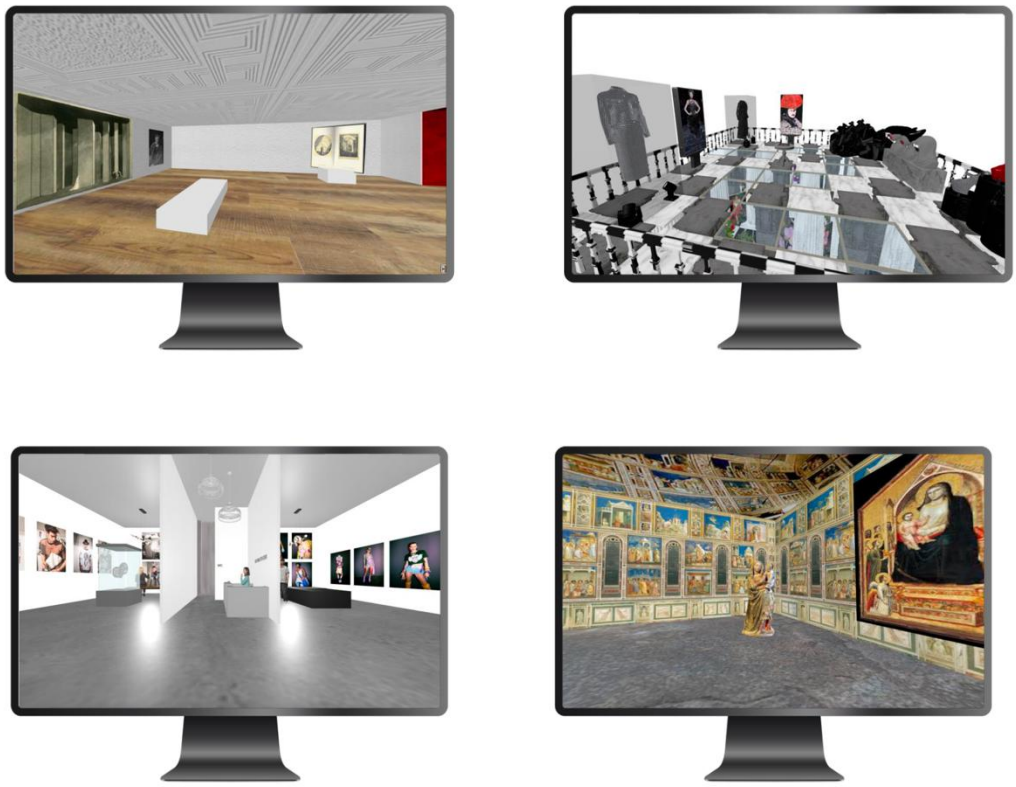
The projects presented recreate immersive virtual rooms where users can explore various museum pieces related to fashion, photography, cinema and music from a first-person perspective. Among the projects presented, some simulate an art exhibition by integrating images representing paintings or photographs. Others incorporate 3D objects representing artworks, statues, or fashion pieces.

When creating these scenes, the students had complete freedom to choose the theme and integrate the various elements explained during the sessions. By incorporating these elements in the form of images, audio, videos, or 3D objects, they built these virtual museums.

To start the practical exercise, they set up a basic room using simple geometries to include boxes (a-box). These boxes, with the attributes specific to HTML tags, were sized and positioned within the 3D space. They then added the attribute that allows textures to be applied, representing the floor, walls, and ceiling of the museums.

Subsequently, working independently with the basic room designed, the students integrated images, videos, audio, and 3D objects related to themes typical of a museum. Figure 16 shows some examples of the projects completed by the students.

Figure 16.
Projects made during the workshop using A-frame.



Source: compiled by authors. Images obtained from the projects hosted on the XR COM LAB website.

5. Discussion and conclusions

This study addresses the need to train new professional profiles for the digital communication ecosystem, who are capable of working with the converging technologies of Industry 4.0 and 5.0.

The theoretical results highlight that this drive must begin within the various educational systems, especially universities, where transformative processes aimed at a sustainable technological ecosystem—one in which the metaverse is a key player—are addressed, as noted by Picarozzi et al. (2024).

Training students in these profiles will integrate metaverse and immersive technologies into the different professional disciplines. We likewise conclude that this transformation process will allow companies and governing bodies to incorporate these new technical specialists, as Rodríguez-Correa et al. (2023).

Training students in these specialised professional profiles will help clarify key conceptual aspects that currently cause significant confusion regarding the boundaries of each technology and their

applications. In this regard, one of the conclusions relates to the distinction between virtual reality tools and the metaverse. Virtual reality is one of the tools that comprises the metaverse, but they cannot be considered synonymous. This point has been noted before by Crespo-Pereira et al. (2023), López-Belmonte et al. (2023) and Laurens-Arredondo (2024), who also confirm the early stage of scientific research on the application of the metaverse in the field of communications.

The results analysed address the research questions posed. Regarding R.Q.1, it is concluded that A-Frame is a useful and straightforward tool for creating virtual reality scenes. Furthermore, it is suitable for introducing undergraduate students to the world of immersive technologies, as previously noted by Santos and Cardoso (2019) and Azevedo et al. (2020). This is because it does not have as steep a learning curve as other virtual creation tools, like Unity or Unreal Engine, a conclusion that is consistent with the findings of Jerald (2014). At the start of the workshop, the vast majority of participants were unfamiliar with this tool, and thanks to the training received, they were able to develop effective virtual projects.

Regarding R.Q.2, which involved A-Frame's potential for developing immersive products, it is concluded that it is a suitable option for university students to carry out their projects. This coincides with the conclusions reached by Pandit et al. (2023), who consider the tool appropriate for creating educational virtual environments, and by Somavarapu et al. (2021), who have demonstrated the value of A-Frame in designing virtual scenes focused on astrodynamics.

From a practical and applied perspective, the results of this research offer an initial insight into the use of A-Frame in university teaching practices, a topic that has already been explored by Takac (2020).

The knowledge acquired during the workshop is regarded by students as a useful introduction to the world of immersive technologies, thereby enhancing their academic and professional capabilities. However, this study does not consider the use of this tool by communication professionals. As such, no definitive conclusions can be drawn in relation to R.Q.2, making it necessary to conduct further research that replicates this methodology with professionals in the field of communication. This is in keeping with the conclusions of Delso Vicente et al. (2024), who call for further study on the integration of the metaverse and immersive technologies in communication companies.

One limitation of the study is that the workshops were carried out with small, incidental samples, meaning that some participants may have responded in a non-systematic or random manner, which could affect the reliability of the results and introduce bias into the data collected. Consequently, the need arises for further longitudinal and cross-sectional studies with larger samples to better analyse the application of the metaverse in communication.This approach aligns with the findings of Caballero et al. (2023) and Rocha-Ibarra et al. (2024), who note the importance of conducting further research to explore the application of the metaverse in other professional fields.

Finally, regarding R.Q.3, which explores students' motivation to continue training in extended reality, the findings indicate that, after completing the workshop, there is a clear interest in furthering their knowledge of immersive technologies and, more specifically, of the A-Frame tool.

This study proposes virtual museum environments related to art in a way that is consistent with the work of other studies that focus on the use of different virtual reality tools to create artistic settings, such as the research conducted by Raya et al. (2021), Kim and Lee (2022), and Jiawei and Mokmin (2023). The interest shown by students in this area echoes the findings of Aznar-Díaz et al. (2018), which highlight the appeal of applying virtual reality in museum contexts. Similarly, and in line with Magallanes Rodríguez et al. (2021) and Díaz-López et al. (2020), training in virtual reality has a positive impact on the desire to continue working with such tools.

The conclusions yield a set of recommendations that should be considered when developing immersive spaces and metaverses, with the aim of contributing to the practical activities of communication companies in this field. The first of these recommendations relates to the key

questions that must be raised at the outset when planning a project, as these will help to properly frame and guide it:

- Does my project meet the basic requirements of the metaverse as a space for virtual exchange and interaction?
- What do I want it for? Is it a functional development or a product that will add value to my brand?
- Do I want it to be a space for users to interact? Or do I simply want a virtual experience with no interaction?

Answering these questions appropriately will help ensure the right solution is chosen. For example, if the space is not intended to be a virtual meeting point between users, it may be more suitable to develop the project using virtual reality tools.

The second recommendation focuses on the need for the creation process of new immersive products to adhere to Clear Communication standards (Prodigioso Volcán, n.d.), since the user experience must be comprehensive and designed to make the intended tasks as simple as possible. This approach will also enable the professionals trained in these new roles who are integrated into companies to build virtual spaces easily, and to communicate clearly how to engage with these metaverse or virtual experiences, thereby offering high-value-added experiences.

Similarly, communication companies should adhere to these standards and integrate these new professionals in order to offer innovative virtual projects within their product and service portfolios, a point highlighted as key by Villarreal Satama (2022).

Finally, this study contributes to the urgent need for digital transformation that promotes the adoption of new formats within communication companies. From an educational standpoint, it aims to provide future professionals with the skills needed to foster critical thinking, supported by innovation and proper literacy in immersive technologies and the metaverse. This new paradigm we are moving towards is already being addressed by authors such as Cuenca-Fontbona et al. (2020) and Manzanarez (2025).

Moreover, this line of action aligns with the strategic priorities of the European Union, which promotes digital skills through initiatives such as the Digital Skills and Jobs Coalition (European Commission, 2020), part of the Digital Decade strategy (2021). Likewise, recent studies warn of the growing demand for specialised profiles in immersive technologies, artificial intelligence, and XR environments both across Europe and in Spain (Inmersivaxr, 2024; CEDEFOP, 2022). Against this backdrop, the European ESCO framework already recognises key competencies such as designing virtual reality and simulated reality experiences in digital environments, as well as creating virtual reality systems, which emphases the strategic importance of this training for employability in an increasingly competitive landscape.

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7. Supplementary material

This section contains references to the study data, as well as the results of the pretest and posttest assessment. The reference material used to conduct the workshops is also provided.

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